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GERMANY

PCT Chapter II
MU DG 2

Your ref.:
Our ref.: P2284PC00 - JOO
Date: 19. juli 2004

Re.: International Patent Application PCT/NO03/00313
Method and an arrangement for determining of content of conductive component of a multi phase fluid flow of a pipe.

Applicant: EPSIS AS

Reference is made to the Search report issued by ISA, Sweden of November 28, 2003. The Examiner made som comments to the claims of the present application. Therefore we now file a new set of claims to be handlet further during the Chapter II of the application.

The DEMAND for PCT-chapter II in this case, was timely filed on April 1, 2004.

In the new set of claims, we have clarified the independent claims 1 and 12 in order to deal with Examiners objections. The claims are marked AMENDED CLAIMS

In the independent claims, we have defined the known features of the invention in the claim preambles, in that the one or more coils is/are arranged around the multi phase flow pipe and supplying an alternate voltage to the coils. Furhter the attenuation of the induced magnetic fields is also mentioned.

In the characterising clauses of the said method/apparatus claims, we have defined the meassuring of the impendance at resonance frequency, and the arrangement of the first and second coils, which are operating so as to cover whole area of the conducting component, i.e. of a conductive component content 0 to 100% content. The conductive component may be water.

Please note that claims 8 and 16 (method and apparatus, respectivley) relate to the feature of using one single coil. This is disclosed in Figure 3 and the acompanying text.

Claims 9 and 17 (method and apparatus, respectivley) relate to the feature of using a number of coils positioned around the pipe. This is disclosed in Figure 6 and the acompanying text.

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All these embodiments are within the scope of the present independent claims 1 and 12, respectively, and should preferably be contained in the same claim set.

We look forward to receiving the FIRST written opinion in this case.

Yours faithfully
AS BERGEN PATENTKONTOR

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Encl. Set of claims.

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AMENDED CLAIMS

1. Method for determining the content of a conductive component of a multi phase flow through a pipe, by supplying alternate voltage to one or more coils being arranged around the fluid conducting pipe, and then detecting the attenuation of the magnetic fields due to the induced power loss dependent or the coil impedance at resonance, dependent on the conductivity of any conductive phase component of the fluid flow, characterized in measuring the impedance of the coils at resonance frequency, said impedance varying as a function of content of the conductive phase, by using

a first coil design having a given number of windings optimised for non-conductive continous mixtures, and

a second coil design of a different number of windings optimised for conductive continous mixtures.

2. Method according to claim 1, characterized in the two coils are operating at two different frequencies in order to compensate for variation in the conductivity, hence determining said conductivity of the conductive phase.

3. Method according to claim 1-2, characterized in using wire or cords including Cu-lices having a thickness less than the electrical skin depth of Cu (copper).

4. Method according to any of preceding claims, characterized in using flat Cu-lices at a thickness of 40 μm.

5. Method according to any of preceding claims, characterized in using a resonance frequency in the range of 1-10MHz, and preferably in the range of 2 to 8 MHz.

6. Method according to any of preceding claims, characterized in using a resonance frequency of 5,5 Mhz in order to obtaining a penetration depth in the multi phase

order to obtaining a penetration depth in the multi phase flow, of about 10 cm, corresponding to at least half the pipe diameter.

7. Method according to claim 1, characterised in using a first coil design of one layer of 15 windings of flat Cu-cord said coil operating at a frequency of f = 2 MHz, and

a second coil design of 4 layers of 4 windings of flat Cu-cord said coil operating at a frequency of f = 9 MHz.

8. Method according to claim 1, characterized in using one single multi turn coil, in particular a 9-turn coil, which is sensitive for conductive liquid content (such as water) in the mixture over the whole range.

9 Method to measure the distribution of a conductive component in the cross section of a pipe, characterized in using a number of coils arranged to the outside surface of the fluid transporting pipe, the coils being arranged to be driven to reconance frequency one at a time, for determining the power loss generated in the alternating magnetic field from one coil at the time.

10. Method according to claim 9, characterized in working out a reconstruction algorithm imaging the water distribution in the meter cross section based on mathematical models of the magnetic field from the coils.

11. Method according to claims 9-10, characterized in exciting one of the coils at a time and use all the other coils as pick up coils and detect the attenuation of the magnetic field from the transmitter to the receiver coils and thus reconstruct a picture of the area of low field penetration being areas of water.

12 Arrangement of determining content of a conductive component of a multi phase flow through a pipe, by

supplying alternate voltage to coils which are arranged around said pipe, and then detecting the attenuation of the magnetic fields due to the induced power loss dependent on the conductivity of the conductive phase of the fluid flow, characterized by

a first coil design having a given number of windings being optimised for non-conductive continous mixtures, and a coil

a second coil having a different number of windings being optimised for conductive continous mixtures,

said coils being arranged for measuring the impedance of the coils at resonance frequency, said impedance varying as a function of content of the conductive phase.

13, Arrangement according to claim 12, characterised by

a first coil design of one layer of 15 windings of flat Cu-cord said coil operating at a frequency of f = 2 MHz, and

a second coil design of 4 layers of 4 windings of flat Cu-cord said coil operating at a frequency of f = 9 MHz.

14. Arrangement according to claims 12-13, characterized in using wire or cords including Cu-lices having a thickness less than the electrical skin depth of Cu (copper).

15. Arrangement according to claims 12-14, characterized in using flat Cu-lices at a thickness of 40 µm.

16. Arrangement according to claim 12, characterized by a multi turn coil, e.g. a 9-turn coil, which is sensitive for water content in the mixture over the whole range.

17 Arrangement to measure the distribution of a conductive component in the cross section of a pipe, characterized in using a number of coils arranged to the outside surface of the fluid transporting pipe, the coils being arranged to be driven to reconance frequency one at a

time, for determining the power loss generated in the alternating magnetic field from one coil at the time.

18. Arrangement according to any of preceding arrangement claims, <u>characterized by</u> a reconstruction algorithm imaging the water distribution in the meter cross section based on mathematical models of the magnetic field from the coils.

19. Application of the arrangement according claims 12-18, for determining the water content of a multi phase flow of oil, hydrocarbon gas and water, in that water is the conductive component to be determined and the oil and gas phases being the non-conductive phase.

20. Application of the arrangement according to claims 12-18, for measuring water content in oil/gas/water multiphase mixture flows wherein the different phases in the crude are separated, i.e. not homogeneous mixed.